Journal of Kerbala University , Vol. 11 No.3 Scientific . 2013

Study the effect of pulse repetition frequency of the shock waves on urinary stones fragmentation

Raed Mohammed Kadhim
University of Kufa-College of Medicine
Physiology and Medical physics Dept.

Dr. Ahmed Jumah Mhows
University of Kufa-College of Medicine
Physiology and Medical physics Dept.

Zuher Hamadi Hussein
Al-Sader Medical city in Najaf
ESWL Unit

Abstract

Extracorporeal shock wave lithotripsy (ESWL) is a noninvasive treatment option for urolithiasis. The aim of this study was to determine the effect of pulse repetition frequency of shock waves on ESWL efficiency in urinary stones fragmentation. Two hundred patients were included in this study. Their age ranging from 16 to 70 years. They divided into two groups. One of the groups was treated with shock waves at 60 pulse/min. and the other group was treated with shock waves at 90 pulse/min. We found that the shock waves with 60 pulse/min. produced better success rate than the shock waves with 90 pulse/min. With 60 pulse/min. about 69% of the patients were stone free after the first ESWL session and only 56% were stone free after the first session with 90 pulse/min. shock waves.

الخلاصة

تستخدم أمواج الصدمة كطريقة آمنة وغير اجتياحية لعلاج حصى المجاري البولية. لقد كان الهدف من هذه الدراسة هو تحديد تأثير المعدل الزمني لتردد الضربات على كفاءة تفتيت الحصى بهذه الطريقة . وقد شملت هذه الدراسة (200) مريض, تراوحت أعمارهم بين 16-70 سنة تم تقسيمهم إلى مجموعتين؛ حيث تم معالجة المجموعة الأولى بمعدل زمني للضربات مقداره 60 ضربة بالدقيقة بينما تمت معالجة المجموعة الثانية بمعدل 90 ضربة بالدقيقة. وقد أظهرت النتائج إن 69% من المرضى في المجموعة الأولى تخلصوا من الحصى بعد الجلسة الأولى للتفتيت و 56% من المجموعة الثانية تخلصوا من الحصى بعد الجلسة الأولى للتفتيت.

Introduction

Urolithiasis is a common condition that effects approximately 5-12% of the population worldwide.(1) Consequently, urinary stone disease has a significant medical and economic impact.(2) Although most patients have only one stone episode, 25% of patients experience recurrent stone formation.(3)

Extracorporeal shock wave lithotripsy (ESWL) is a noninvasive treatment option for urolithiasis.(4) It is the disintegration of urinary stones using focused ultrasound shockwaves. It has been the method of choice in urolithiasis since its introduction over more than 20 years ago.(5) After introduction in 1980, ESWL dramatically changed the management of renal and ureteral calculus disease.(6)

ESWL success rates for renal and ureteral stones vary from 60% to 90% depending on a variety of stone and patient factors including stone composition, size, location and patient habitus.(4)

In early generations of ESWL, electrohydraulic shock wave generation principle or the piezoelectric principle have switched to the electromagnetic shock wave.(5) Lithotripters generate pressure pulses that are steepened up by nonlinear propagation to shock waves in the focus, which is directed at the urinary stones, and appear impressive in their steepness and maximal peak pressure values (fig.1). Pressure peaks normally range from 50 to 150 MPa. And yet, this often propagated and advertised peak pressure value aloneis irrelevant for stone disintegration. It has been scientifically proven that the energy content of an expanded focus with moderate peak sound pressure result in extensive stone disintegration, and not the narrow, high-pressure peak (7)

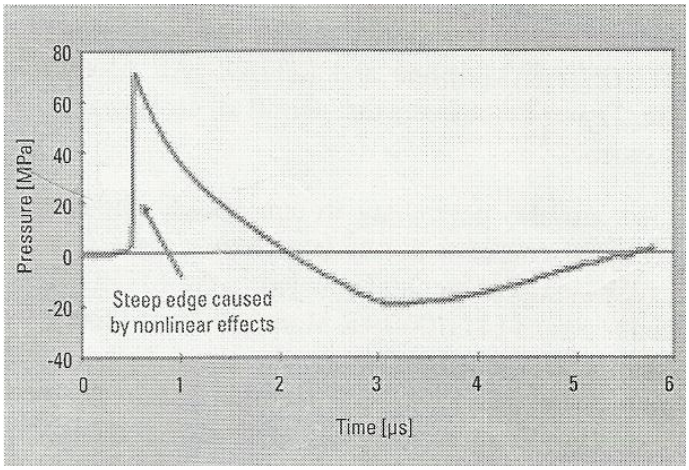

Fig. 1 Typical time-dependent behaviour of pressure in shock wave focus

In resent ESWL unit, a charged high-voltage capacitor is instantaneously discharged via a flat coil, in front of which a metal membrane is situated as a secondary coil. The mutual magnetic repulsion between the two coils (Lenz' rule) pushes the membrane in an adjacent water volume, thereby generating a plane pressure wave which is then concentrated in the focus by an acoustic lens. This plane wave directly after the membrane already embodies all characteristics essential for stone disintegration, e.g, energy. (8)

Effects of shockwaves

Fragmentation of a stone occurs when the force of shockwaves overcomes the tensile strength of the stone. (6) Knowledge of the precise mechanism of SWL induced stone fragmentation is incomplete. (9)

Fragmentation may be produced by direct force, erosion, or cavitation. In direct fragmenting force, shockwaves hit the anterior surface of the stone and cause the stone to split. The compressive component of the shockwaves proceeds through the stone, creating a pressure gradient that causes the stone to fragment by erosion. Shockwaves that are reflected off the stone and return toward the generator constitute the tensile component.

In cavitation, gaseous bubbles are produced by shockwaves in a liquid medium. The bubbles collapse explosively, creating microjets that fracture and erode the calculus. This process can be monitored with real-time sonography during the treatment, and it appears as swirling fragments and liquid in the focal zone. (6)

Theoretically, the effect of reduced treatment rates on stone fragmentation appear to be modulated by optimized bubble dynamics in the blast path, which result in improved cavitation.(4)

Materials and Methods

The present work was performed to study the effect of PRF of shock waves on the result of ESWL during urinary stones fragmentation. Two groups included in this study. One hundred patients (group I) their urinary stones are treated with ESWL at 60 pulse/minute shock waves rate. Other one hundred patients (group II) treated by the same ESWL system at rate of 90 pulse/minute. The age range for both groups was 16 to 70 years of age.

The size of urinary stone in both groups ranged from 0.8cm to 2cm.

All data had been collected from practical work in the ESWL unit in Al-sadder Medical City in Najaf. The ESWL system model in that hospital was Wolf model (Germany).

Results

The results of this study were summed up in figures 2 and 3. All the patients (in both goups) were chosen with one radiopaque stone.

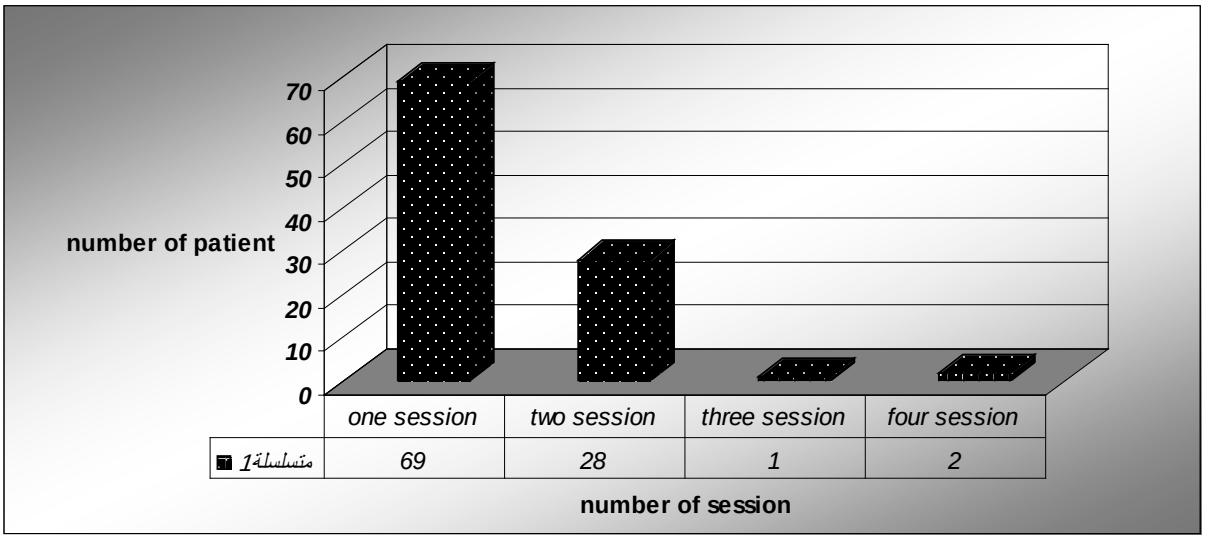

Fig.1 patiens division according to the ESWL sessions rquired to be stone free with 60 pulse/min. shock waves.

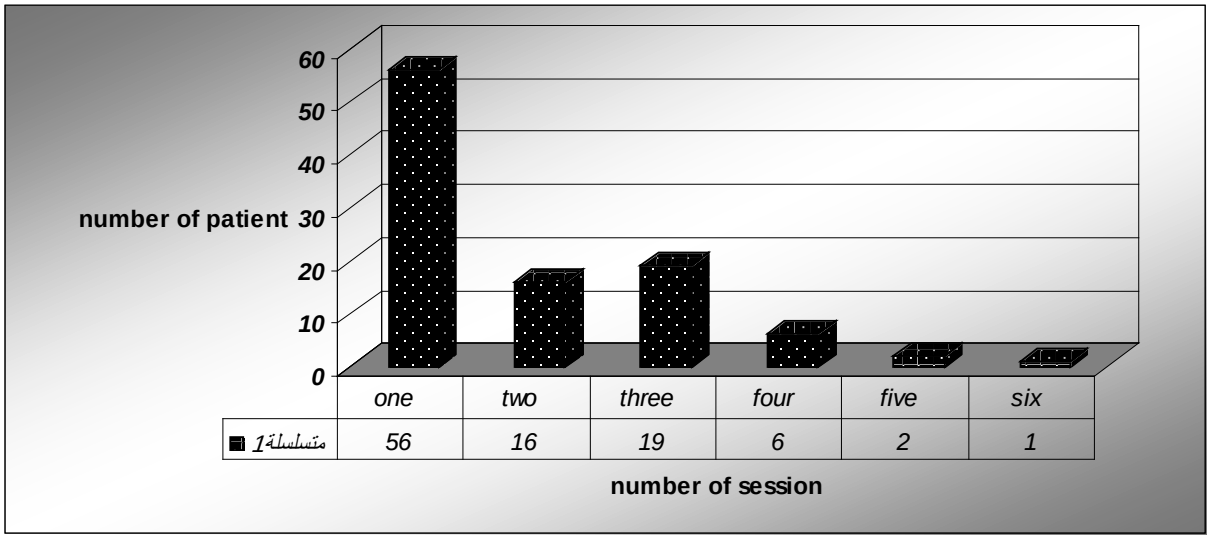

Fig.2 patiens division according to the ESWL sessions rquired to be stone free with 90 pulse/min. shock waves.

Discussion

The efficiency of treating urinary stones using ESWL depends on the location, size and composition of the urolithiasis.

New generations of ESWL makes it possible to apply shock waves with different frequencies.

Our results show at 60 pulse/min. about 69% of the patients were stone free after one ESWL session and 28% of them were stone free after two ESWL session with maximum required sessions were 4 sessions only.

While with 90 pulse/min, 56% of the patients were stone free after the first ESWL session, 16% of them after the second session and the maximum number of sessions may reach to 6 sessions.

Khaled Madbouly et al. study the effect of shock wave lithotripsy rate (60 and 120 pulse/min) on outcome in patients with urinary stones. Their results were highly comparable with our results.(10)

While Azat et al. found that there was no significant change in efficiency of ESWL in treatment of urolithiasis with 30 and 60 pulse/min. (11)

Conclusion

The success rate of urinary stone fragmentation by ESWL is highly dependent on pulse repetition frequency of shock waves. We recommended the use of 60 pulse/min. frequency in order to improve success rate better than that with the use of 30, 90, and 120 pulse/min. frequency.

References

1. Imre Romics, Gyorgy Siller, Ralf Kohnen, Stelios Mavrogenis, Jozsel Varga, and Endre Holman. Improving stone clearance after extracorporeal shock wave lithotripsy in urolithiasis patients by a special terpene combination (rowatinex): result of placebo-controlled, rondomized trial. European Urology Supplement. Vol:9 ; P:819-825;(2010).
2. Tiselius HG, Ackermann D, Alken P, Buck C, Conort P, Gallucci M. Guidelines on urolithiasis. Eur Urol ; 40:362-71. (2001)
3. Thomas Knoll; Epidemiology, pathogenesis, and pathophysiology of urolithiasis ; European Urology Supplement. Vol:9 ; P:802-806;(2010).
4. J. D'A. Honey, T.D. Schuler, D.Ghiculete, K.T.Pace and the Canadian endourology group; A randomized, double-blind trial to compare shock wave frequencies of 60 and 120 shocks per minute for upper ureteral stones; The journal of urology,vol.182, P:1418-1423.(2009)
5. B.Granz, M. Lanski, R. Nanke, M. Mahler, A. Rohwedder, C. Chaussy, S.Thuroff; Lithostar modularis-A proven system with new, innovative features; Electromedia 71, no.1, P:53-57. (2003)
6. Afshar Zomorrodi; Innovative technique to increase the efficacy of extracorporeal shock wave lithotripsy (ESWL) in urinary stones; AJU vol.5, no.3, P:55-58, september (2007)
7. Granz B, Kohler G. what makes a shock wave efficient in lithotrepsy. J.stone disease ;4:123-128.(1992)
8. Granz B, Koher G. Quantitative assignment of shock wave parameters to stone disintegration in lithotrepsy. Conference proceedings ultrasonic international, Butterworth heinemann; P:61-64.(1991)
9. Choi MJ, Coleman AJ and Saunders JE; The influence of fluid properties and pulse amplitude on bubble dynamics in the field of a shock wave lithotripter; Phys Med Biol, 38:1561 (1993)
10. KHALED MADBOULY, ABDEL MONEIM EL-TIRAIFI, MOHAMED SEIDA, SALAH R. EL-FAQIH, RAMIZ ATASSI AND RIYADH F. TALIC; SLOW VERSUS FAST SHOCK WAVE LITHOTRIPSY RATE FOR UROLITHIASIS: A PROSPECTIVE RANDOMIZED STUDY ; JOURNAL OF UROLOGY; Vol. 173, 127–130, January (2005)
11. Azat Ch, Pacik D, Varga G, Hajny M; The effeciency of urolithiasis treatment with extracorporeal lithotrepsy in relation to the shock waves frequency; Bratisl Lek listy; 111 (12); P:644-646.(2010)